Autonomous Evolutionary Art

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2013

document version
Publisher's PDF, also known as Version of record

Link to publication in VU Research Portal

citation for published version (APA)
den Heijer, E. (2013). *Autonomous Evolutionary Art*. [PhD-Thesis - Research and graduation internal, Vrije Universiteit Amsterdam].

17 SUMMARY

GENERATIVE Art is a field in which one investigates automated processes that produce works of art, music, poetry, etc. Evolutionary Art is a subfield within Generative Art, and uses evolution as a model to evolve images, music etc. The creation of images using evolution is done as follows; one starts with a population of small programs; the programs are called the 'genotypes'. Each genotype produces one unique image, and the image is called the 'phenotype'. Each image is evaluated with one or more aesthetic functions, and the image receives a fitness score. Many evolutionary art systems use a human observer to determine the fitness score, whereby the observer is presented with a number of images, and the observer selects zero, one, or more images that will survive into the next generation. Some recent evolutionary art systems (including the one described in this thesis) utilize one or more automated fitness functions that calculate certain aesthetic properties of the images to calculate the fitness. At each generation, a number of individuals are selected from the population (based on their fitness scores) to perform crossover (reproduction) and mutation, and this results in new offspring, new genotypes and thus new phenotypes. These new images are also evaluated, and this cycle (or generation) is repeated a number of times, until a stopping-criterium has been met.

This thesis investigates a number of relevant issues within evolutionary art. Part 1 investigates the possibility of excluding human aesthetic evaluation from evolutionary art through the use of aesthetic measures. The aesthetic measures calculate an aesthetic score of an image and this score is used as the fitness value of the individual in the population. This thesis describes seven of these aesthetic measures in detail, and compares the differences in the visual output when using these aesthetic measures. Next, we investigate the combination of aesthetic measures. With the exclusion of human aesthetic evaluation we have obtained an *autonomous* evolutionary art system.

Next to the investigation of aesthetic measures, this thesis describes, in part 2, a number of topics in genotype representation in evolutionary art. We start by describing the limitations of one of the most important genotype representations within contemporary evolutionary art systems; the symbolic expression tree (or Lisp expression). We propose two alternative genotype representations for evolutionary art; first we describe the use of SVG or Scalable Vector Graphics. SVG consists of a number of geometric primitives, and also has a complex primitive called the 'path' element. With these primitives, one has more expressive power within an evolutionary art system, and we show that it is possible to evolve both abstract and represen-

tational art using SVG. Next, we describe my Glitch genotype; Glitch is a very recent development with the computer graphics community, and it consists of the direct manipulation of the binary encoding of images. Glitch operations may result in very spectacular visual results, but they may also result in no visual effect whatsoever, or they may results in the 'destruction' of the image, whereby the image is no longer readable by image software. The new Glitch genotype consists of a 'recipe' of one or more glitch operations on a single image. The Glitch genotype can be regarded as a complex variety of the well-known Photoshop filters.

Part 3 of this thesis describes another important issue in evolutionary computation in general and evolutionary art in particular; population diversity. We believe that evolutionary art benefits more from exploration than exploitation, and this requires that population diversity remains at a steady, high level. We describe two approaches to maintain population diversity; first we describe the use of custom genetic operators that perform a local search step to maintain diversity. Next, we investigate the use of structured populations like island models and cellular evolutionary algorithms, and their effect on population diversity.